



Armed Forces College of Medicine AFCM



Digestion and absorption along the GIT 1

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INTENDED LEARNING OBJECTIVES (ILO)



By the end of this lecture the student will be able to:

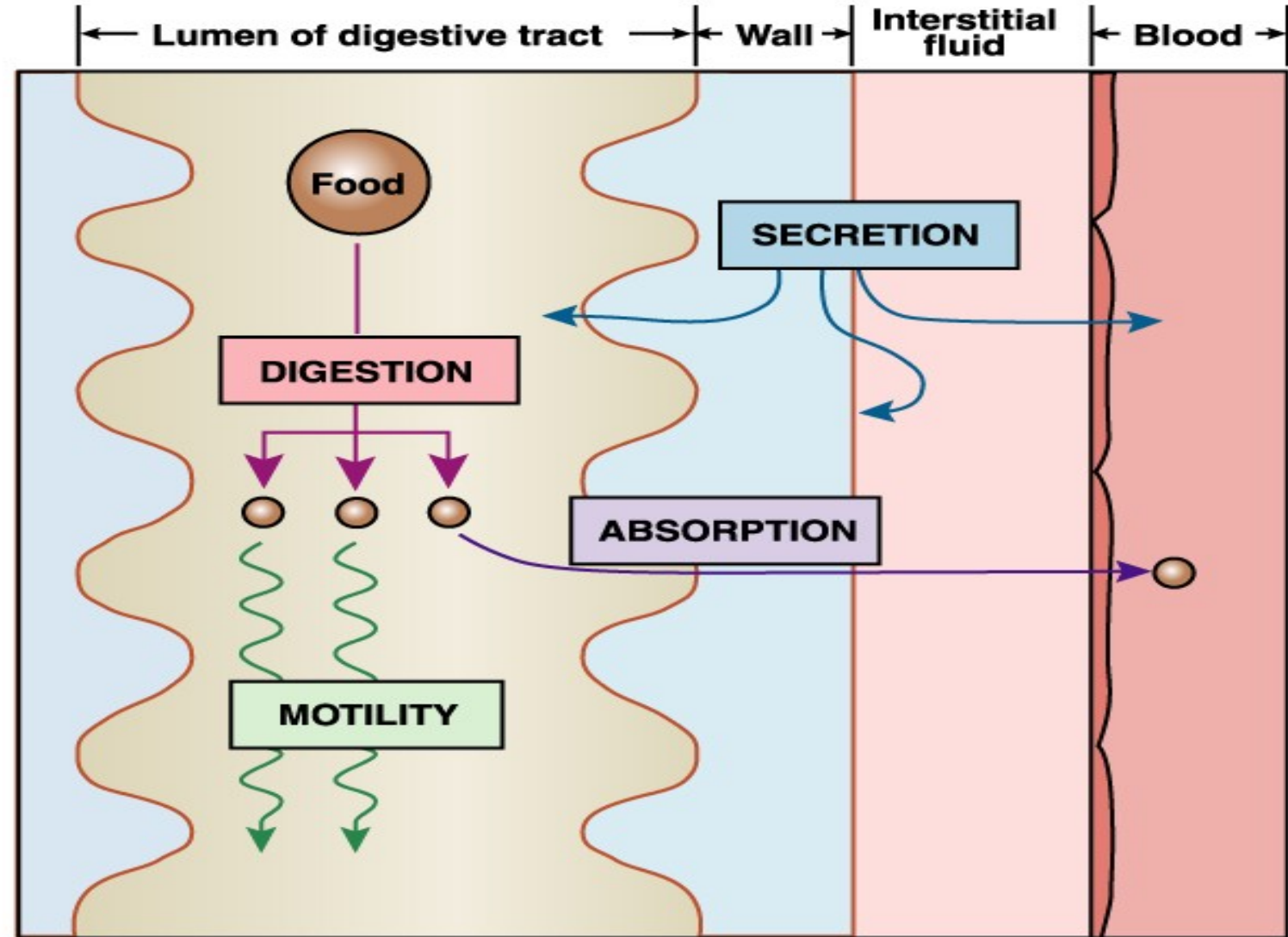
- 1. Describe the Stages of Digestion**
- 2. Summarize the digestion and mechanism of absorption of different nutrients (carbohydrate and protein, along GIT (transport carriers)).**
- 3. Apply knowledge to solve clinical problem**



Processes involved in Digestion



➤ A process essential for the conversion of food into a small and simple form (breakdown of food molecules into smaller subunits, simple components, to be absorbed



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Stages of Digestion



Mechanical digestion



- Physical breakdown of food into smaller particles
- Mouth “teeth” → Chewing
- Stomach → Churning action
- Small intestines → Segmentation movement

Stages of Digestion



Chemical digestion



Series of hydrolysis reactions by enzymes “from saliva, stomach, pancreas and intestines” → small particles □ easily absorbed

- Carbohydrates → monosaccharides
- Proteins → amino acids
- Fats → glycerol & fatty acid
- N.B.: Vitamins, minerals & water – No

Stages of Digestion



- **Digestion** occurs in the GIT

lumen

* Mechanically & * Chemical Digestion of proteins

Chemically

- Enzymes catalyze hydrolysis

when:-

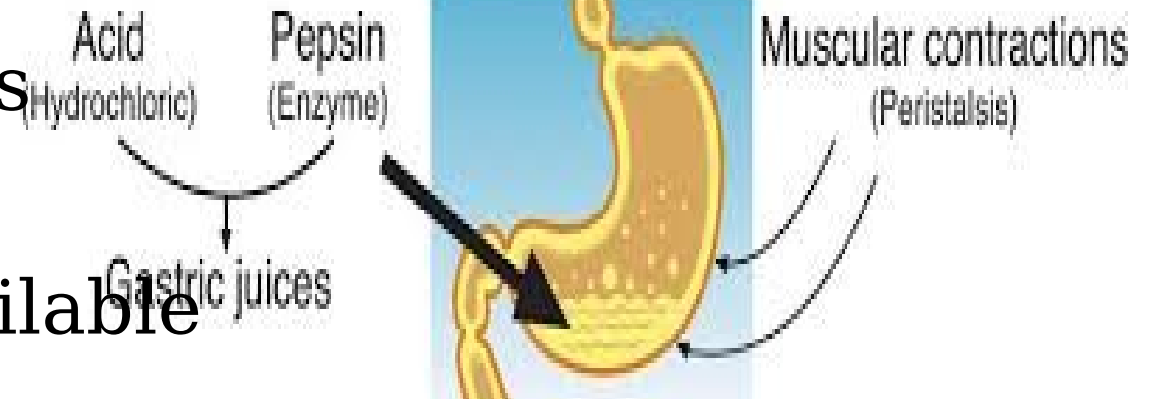
- * Correct substrate is available
- * pH is optimal
- * Temperature is optimal

- New Five Year Program GIT Module

GIT secretions □ optimize the

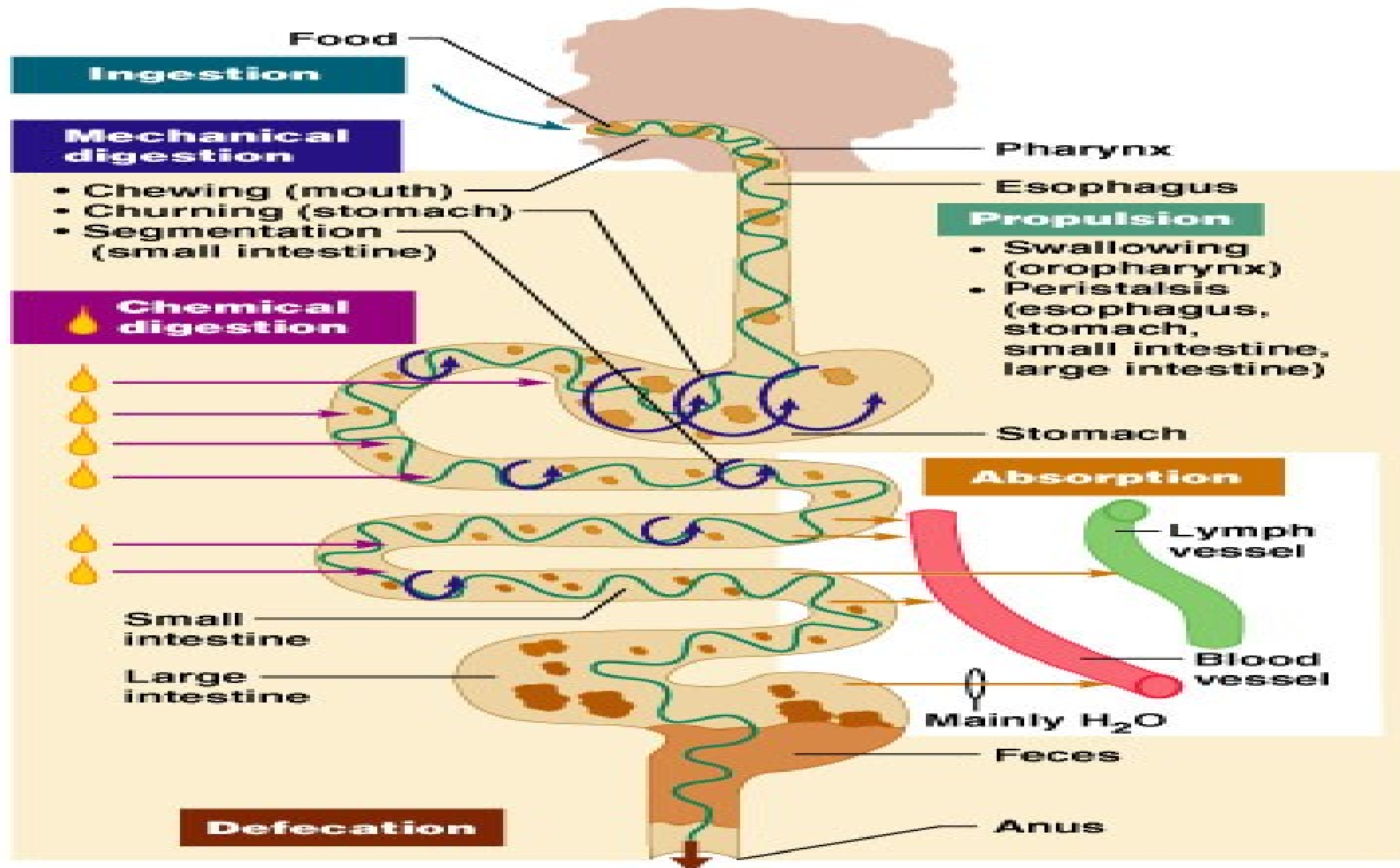


Mechanical Digestion



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%2Fbooks%2Fan-introduction-to-
nutrition
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75fe30bdc93e573.jpg&imgrefurl=https

Stages of Digestion



Now lets think about a piece of bread have been chewed. What is going to happen for it till it is digested to its simple nutrients

Try to put it in concept map



Absorption



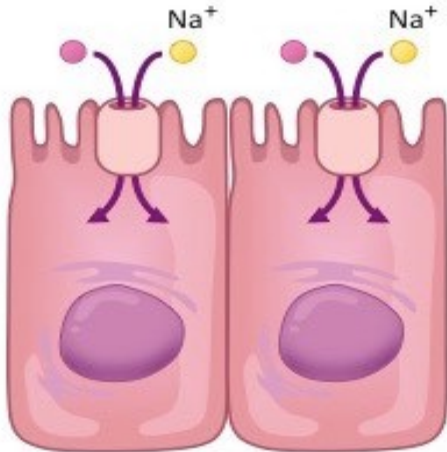
- ❖ It is the process of transporting (Passage) of small digested end products (nutrients) from the lumen of the gut into blood stream or lymphatic vessel
- ❖ Some absorption takes place in the mouth, stomach, small and large intestine
- ❖ **Small intestine** is the primary site **for digestion** and **absorption** $\approx$ 90% of food



Mechanisms of absorption

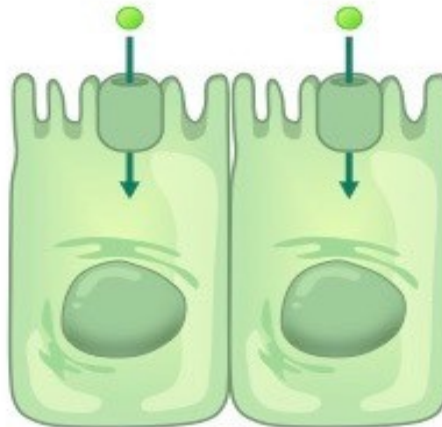


Co-transport (Active)



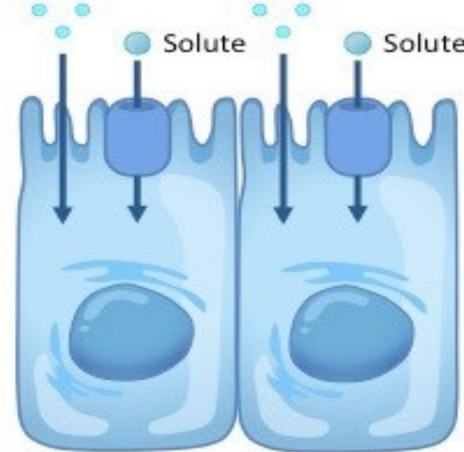
For: Glucose, Amino Acids

Facilitated Diffusion



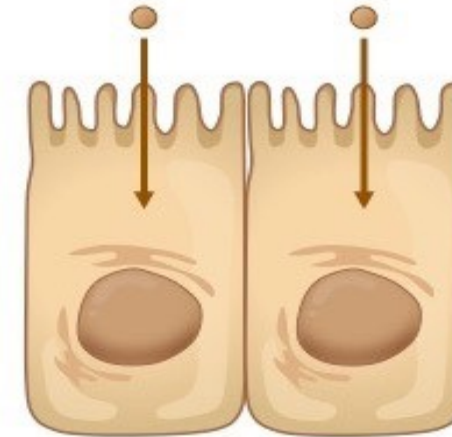
For: Monosaccharides

Osmosis



For: Water

Simple Diffusion



For: Triglycerides

Endocytosis

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Transport of nutrients



- *Water-soluble nutrients*

*GI tract
Capillaries*

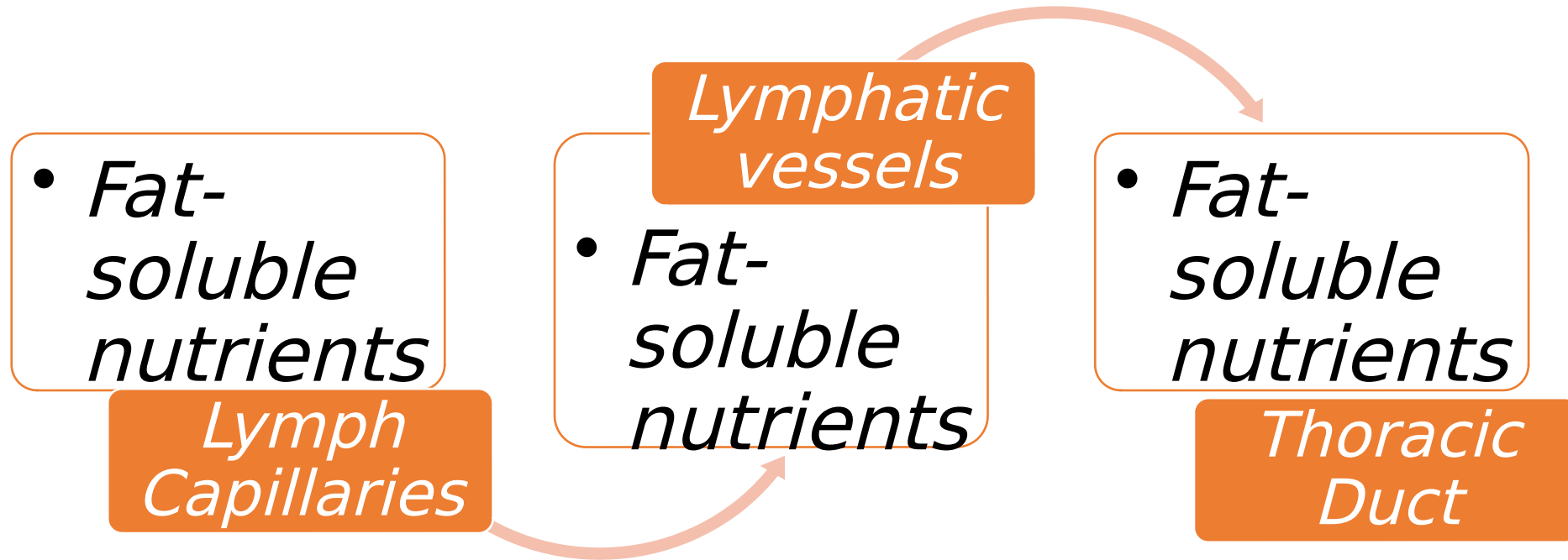
*Hepatic
Portal Vein*

- *Water-soluble nutrients*

- *Water-soluble nutrients*

Liver

Transport of the nutrients



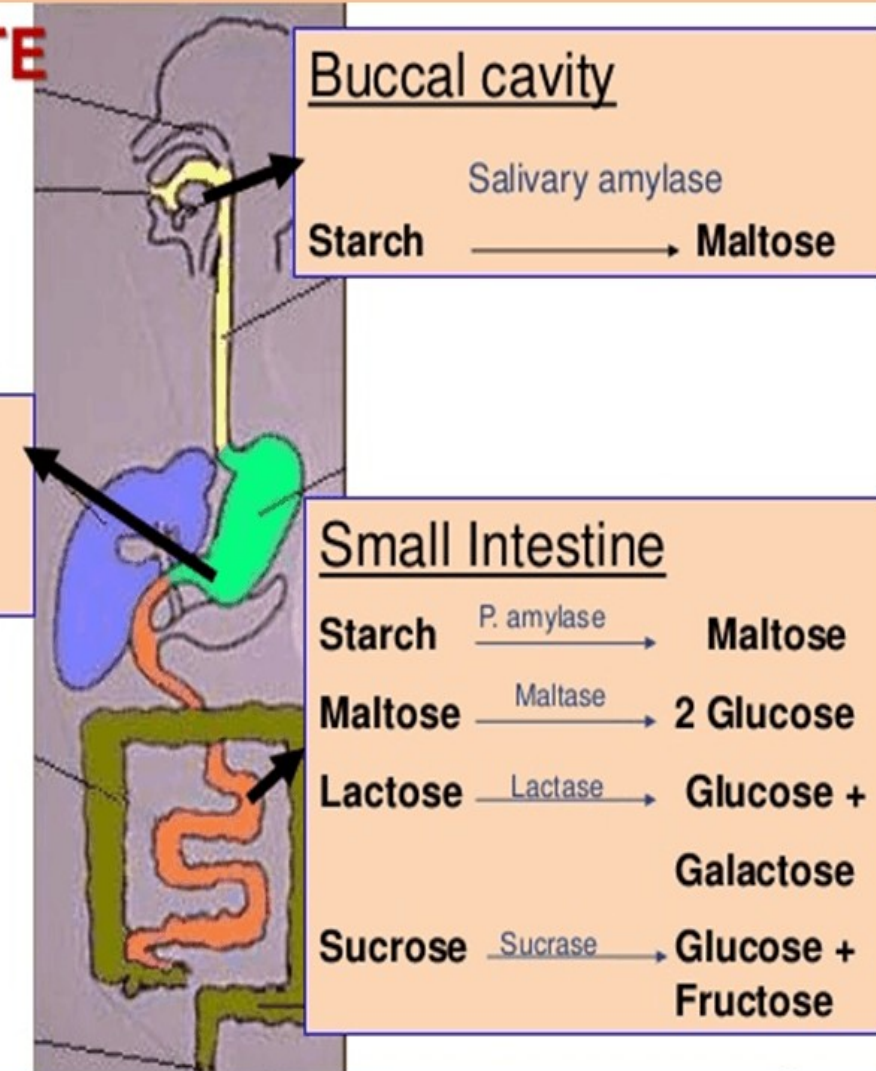


Digestion of CHO



Source	Enzyme	Activator	Substrate	Products
Salivary glands	Salivary α -amylase	Cl ⁻	Starch	Maltose and dextrins
Exocrine pancreas	α -amylase	Cl ⁻	Starch	dextrins, maltotriose, and maltose
Small intestine	Maltase	...	Maltose, maltotriose, α dextrins	Glucose
	Lactase	...	Lactose	Galactose and glucose
	Sucrase	...	Sucrose; maltotriose maltose	Fructose and glucose

HYDRATE STION



CHO absorption

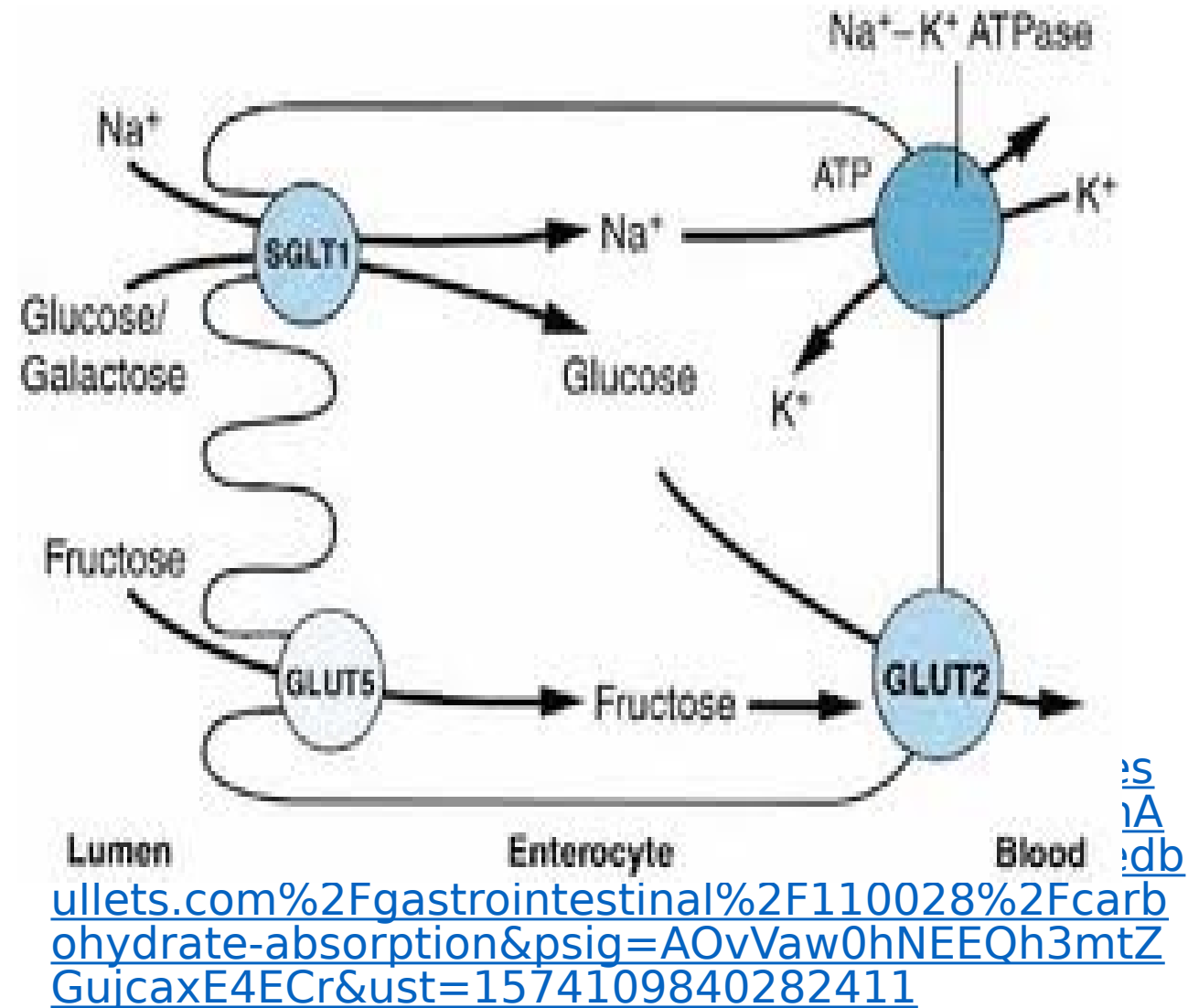


Small intestine

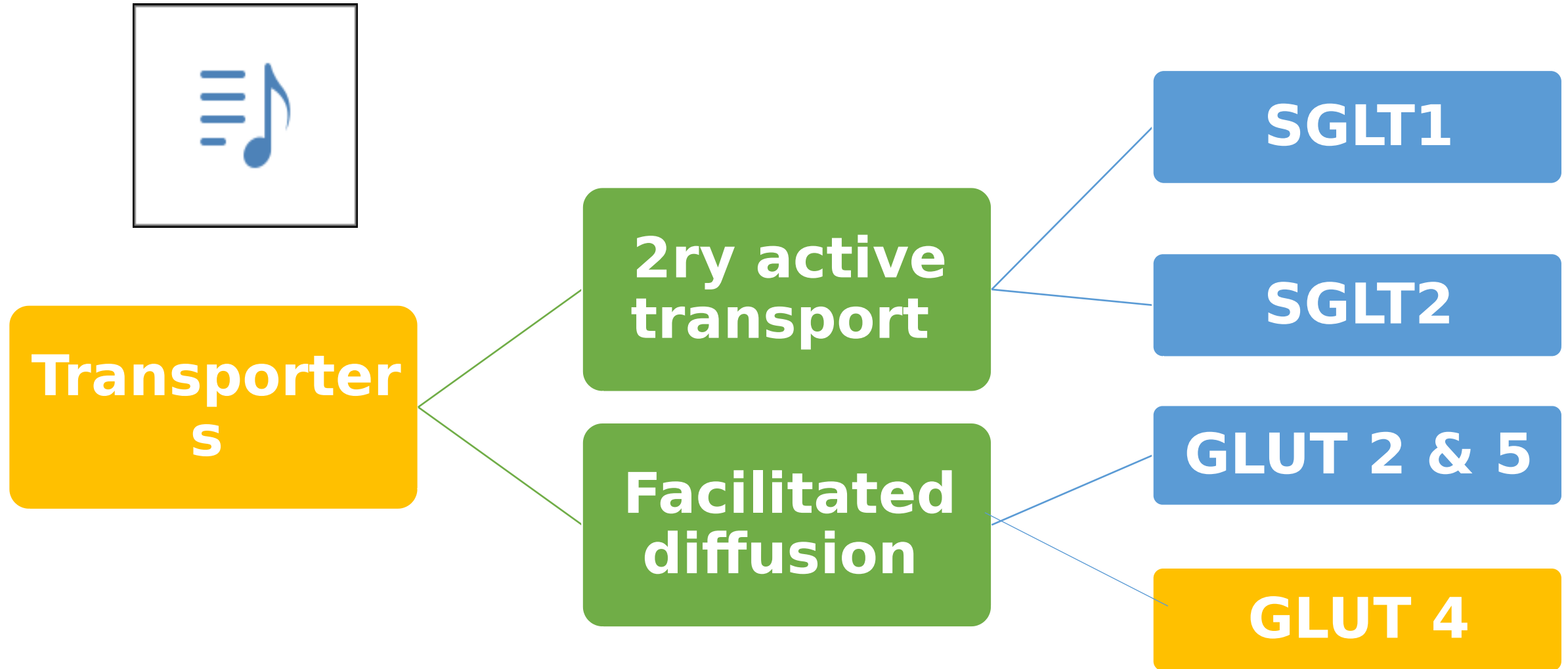


Enterocytes absorb

- 1) **glucose and galactose** by “**Na⁺-dependent secondary active transport**”
- 2) **fructose** “**facilitated diffusion**”
- 3) **Pentoses** by **simple diffusion**



Glucose transporters





Incretins and DPP4 inhibitors



After intake of a meal and before blood glucose level increases, released GIT hormones cause release of insulin from β cell of pancreas “anticipatory increase”.

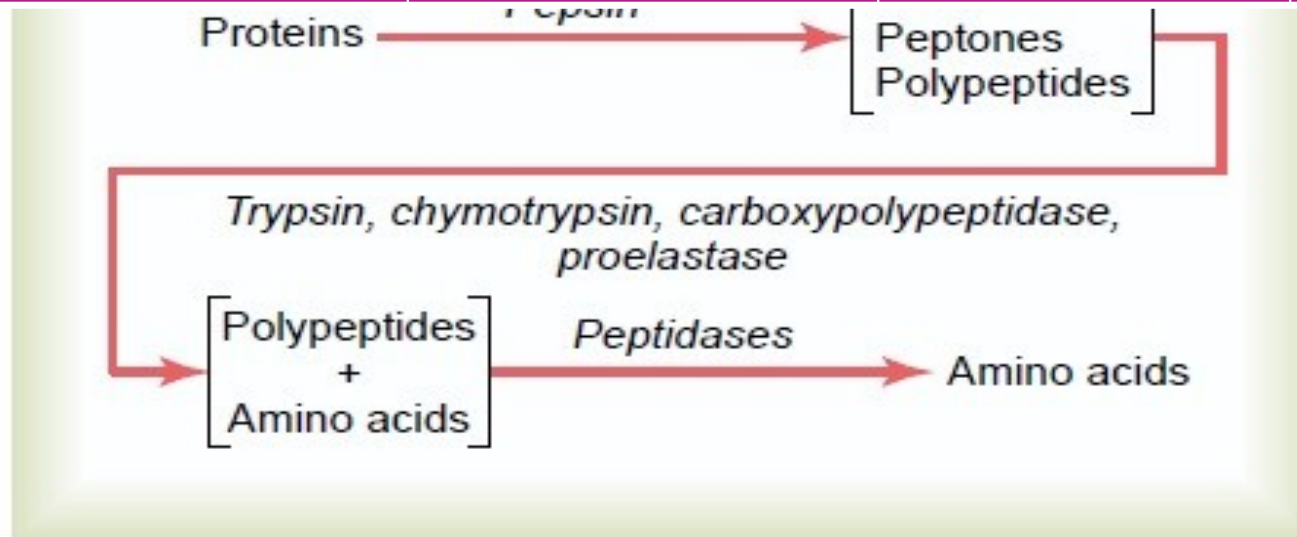
- ✓ The most potent hormones enhances the release of insulin are GLP-1 and GIP.
- ✓ These hormones are called *incretins* that affect endocrine pancreas of normal and diabetics.
- ✓ DPP4 are enzymes present on cell surfaces that degrade the incretins
- ✓ New line of drugs for diabetes is DPP4 inhibitors that enhance insulin release.



Digestion of proteins



Source	Enzyme	Activator	Substrat	Products
Stomach	Pepsins (pepsinogens)	HCl	Proteins and polypeptides	Cleave peptide bonds



Small
intestine



Intestinal
lining



Protease

Small peptides,
amino acids



Active transport

Amino acids in
blood stream



Digestion of proteins



Source	Enzyme	Activat or	Substrate	Catalytic Function or Products
Exocrine pancreas	Trypsin (trypsinogen)	Entero- peptid ase	Proteins and polypeptid es	Cleave peptide bonds on of basic amino acids
	Chymotrypsin s (chymotrypsin ogens)	Trypsin	Proteins and polypeptid es	Cleave peptide bonds on aromatic amino acids
	Elastase (proelastase)	Trypsin	Elastin, some other proteins	Cleaves bonds on aliphatic amino acids
	Carboxypeptid	Trypsin	Proteins	Cleave carboxyl



Digestion of proteins



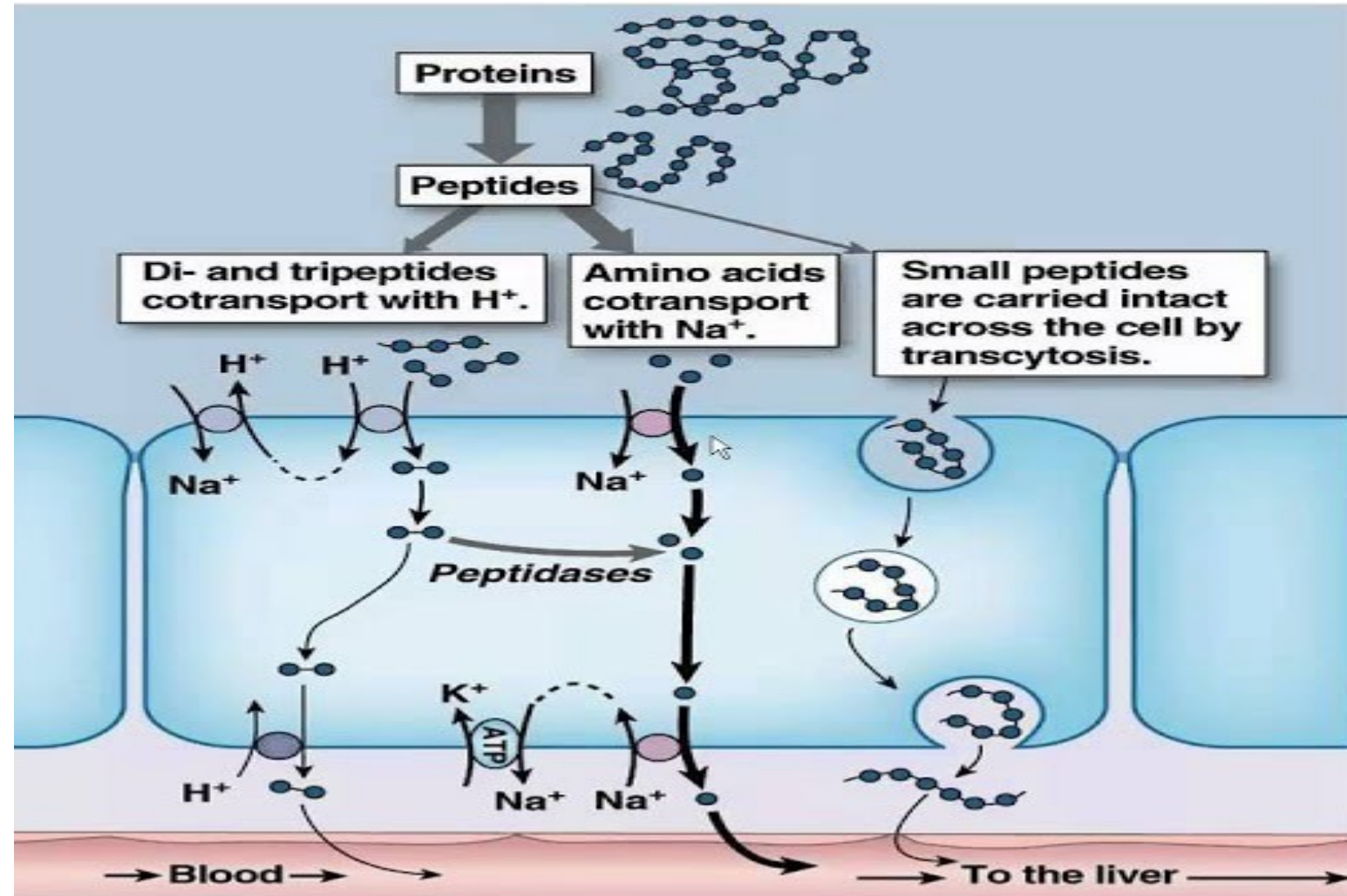
Source	Enzyme	Activat or	Substrate	Products
Intestinal mucosa	Enteropeptidase	. . .	Trypsinogen	Trypsin
	Carboxypeptidases	. . .	Polypeptides	Cleave carboxyl terminal amino acid from peptide
	Aminopeptidases	. . .	Polypeptides	Cleave amino terminal amino acid from peptide
	Endopeptidases	. . .	Polypeptides	Cleave between residues in midportion of peptide
	Dipeptidases	. . .	Dipeptides	Two amino acids



Absorption of proteins



- ✓ Whole Proteins are absorbed by **endocytosis**, especially in infants.
- ✓ Amino acids are absorbed by **facilitated diffusion**
- ✓ Di and Tri peptides are absorbed by **facilitated**



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Summary



Foodstuff	Enzyme(s) and source	Site of action	Path of absorption
Carbohydrate digestion <pre>graph TD; A[Polysaccharides and disaccharides] --> B[Oligosaccharides and disaccharides]; B --> C[Lactose]; B --> D[Maltose]; B --> E[Sucrose]; C --> F[Galactose]; C --> G[Glucose]; D --> G; E --> G; E --> H[Fructose]</pre>	Salivary amylase Pancreatic amylase Brush border enzymes in small intestine (dextrinase, glucoamylase, lactase, maltase, and sucrase)	Mouth Small intestine Small intestine	The monosaccharides glucose and galactose are absorbed via cotransport with sodium ions; fructose passes via facilitated diffusion. All monosaccharides enter the capillary blood in the villi and are transported to the liver via the hepatic portal vein.
Protein digestion <pre>graph TD; A[Protein] --> B[Large polypeptides]; B --> C[Small polypeptides, small peptides]; C --> D[Amino acids (some dipeptides and tripeptides)]</pre>	Pepsin (stomach glands) in the presence of HCl Pancreatic enzymes (trypsin, chymotrypsin, carboxypeptidase) Brush border enzymes (aminopeptidase, carboxypeptidase, and dipeptidase)	Stomach Small intestine Small intestine	Amino acids are absorbed via cotransport with sodium ions; they enter the capillary blood in the villi and are transported to the liver via the hepatic portal vein.

Lecture Quiz



1) Trypsin has all of the following properties EXCEPT:

- a) It can be activated by enterokinase.
- b) It is stimulated mainly by secretin.
- c) It is secreted as an inactive precursor.
- d) It is more active at pH 8 than at pH 2.
- e) It activate other pancreatic enzymes

C

2) Intestinal absorption of proteins occurs by:

- f) Secondary active transport.
- g) Filtration.
- h) Osmosis.
- i) Simple diffusion
- j) Bulk flow

a

SUGGESTED TEXTBOOKS



- 1) Ganong's "Review of Medical Physiology".**
- 2) Guyton and Hall "Textbook of Medical Physiology".**